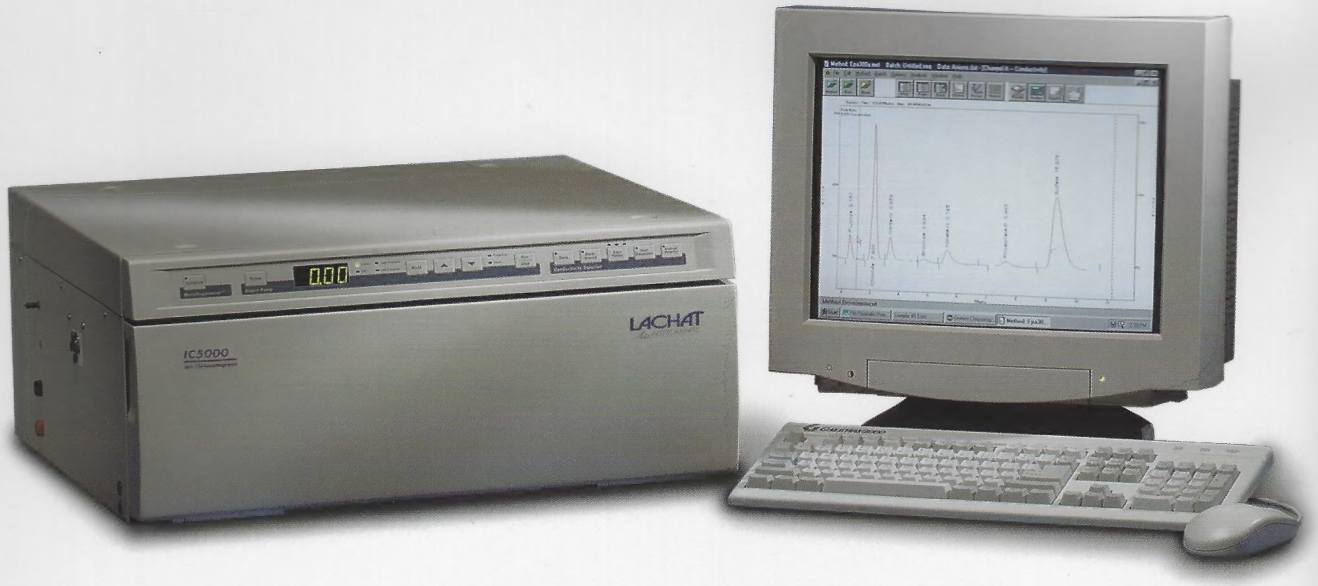
IC5000
Ion Chromatography System

LACHAT INSTRUMENTS

IC5000
Ion Chromatography System



- **Quaternary gradient pumping and on-line eluent preparation**
  to improve separations in complex samples
- **In-line sample filtration to 0.8 µm**
  to eliminate manual filtrations and extend analytical column life
- **Automated Anion/Cation column switching**
  to enable overnight runs
- **Advanced MicroSuppressor™**
  to enhance signal-to-noise ratio by over 100 times
- **Automated standard and sample dilutions**
  to save time and improve accuracy
- **Unique 2 year warranty**
  to provide the ultimate in protection of your investment
- **Range expansion**
  to reduce or eliminate off-scale re-runs
- **Post-column derivatization and colorimetric detection**
  to profile such species as transition metals, bromate, chromium and cyanides
- **Enhanced detection of UV absorbing ions**
  to complement conductimetric detection

TWO YEAR 2 WARRANTY

The IC5000 Ion Chromatography System was user-designed to incorporate all of the features required of an environmental ion chromatograph into a single, compact and economical package. The IC5000 offers the greatest value available to environmental testing labs to perform both compliance monitoring and project work.

You can select among the following options to optimally address your technical and budgetary requirements:

- **Anions Profiling**
- **Cations Profiling**
- **Organic Acids Profiling**
- **Metals Profiling**
- **Advanced MicroSuppressor**
- **In-Line Sample Filtration**
- **XYZ Autosampler**
- **Anions/Cations Automatic Column Switching**
- **Quaternary Gradient Pump**
- **Automated Standard and Sample Dilutions**
- **UV-Visible Detector**

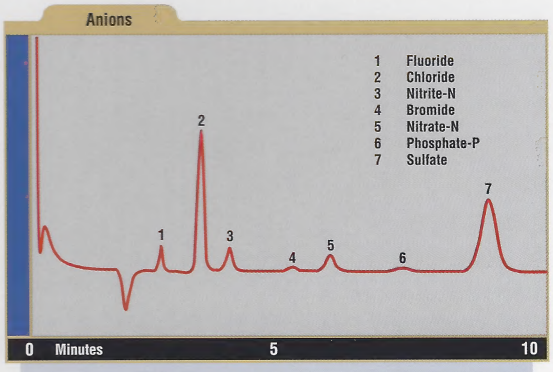
No matter which configuration you choose, the IC5000 comes with all fluidics pre-connected and the analytical methods loaded in software so you can begin to use the product right out of the box.

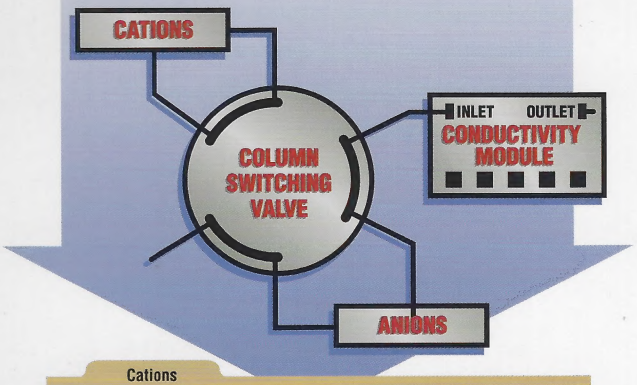
The IC5000 design incorporates a highly organized fluidic train for easy operation and maintenance. To access all components, just open the door.

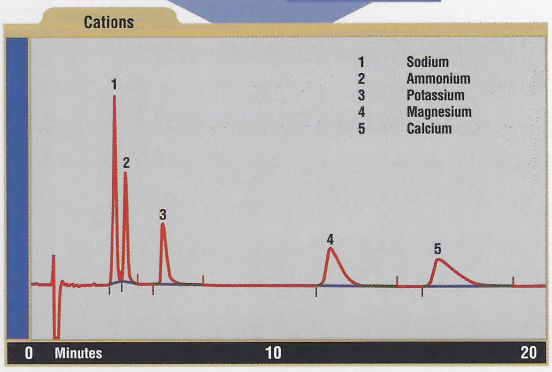
1. **Dual Loop Injection Valve**
2. **Anions Guard Column**
3. **Anions Analytical Column**
4. **Cations Guard Column**
5. **Cations Analytical Column**
6. **MicroSuppressor**
7. **Column Switching Valve**
8. **Eluent Pump**
9. **Gradient Generator**

Automatic Column Switching

The IC5000 can be configured to be two analyzers in one. A valving system allows automatic changeover between anions and cations so two classes of ions can be determined on the same instrument, automatically and even run overnight followed by automatic system shutdown.







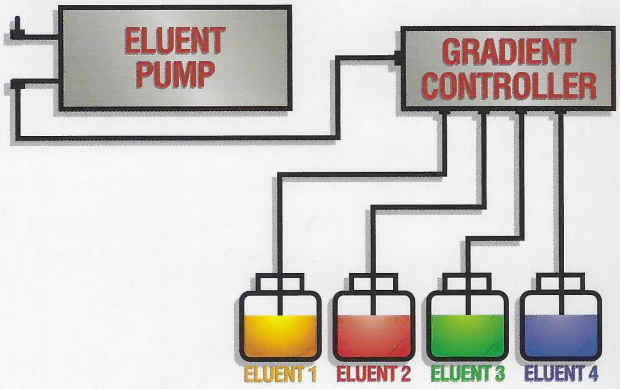
This is accomplished very easily in the Omnion IC Software System in which a specific analytical method is associated with each sample. In order to run anions followed by cations, the operator simply defines a batch of samples associated with the anions method followed by samples associated with the cations method. Once all anions method samples are run, column and eluent valves are automatically switched, the cations system is equilibrated and all cations method samples are run.

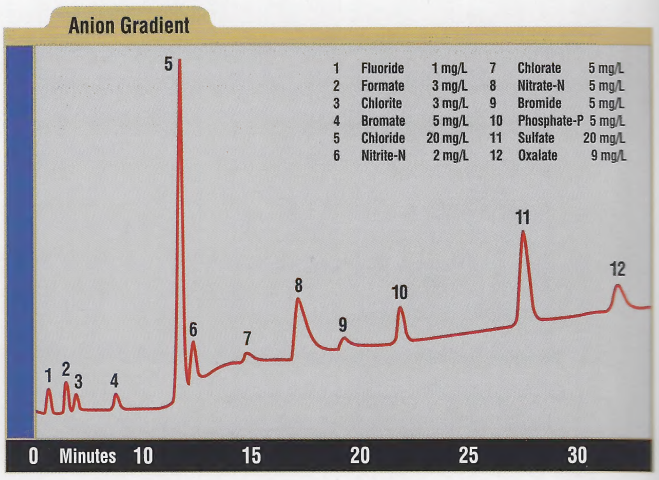
On-Line Eluent Preparation and Gradient Generation

The IC5000 also features on-line preparation of working eluent. This is accomplished by pumping a concentrated stock solution of eluent to the gradient controller where a programmed volume of diluent is metered in. This is used not only to prepare eluent for an isocratic separation, but also to deliver up to three gradients of a single eluent to the column

Gradient Programming

With the IC5000 Quaternary Gradient Option, up to four eluents can be programmed during a run using linear, concave or convex gradient models. Gradient programming enables the relatively rapid separation of complex samples with excellent resolution.

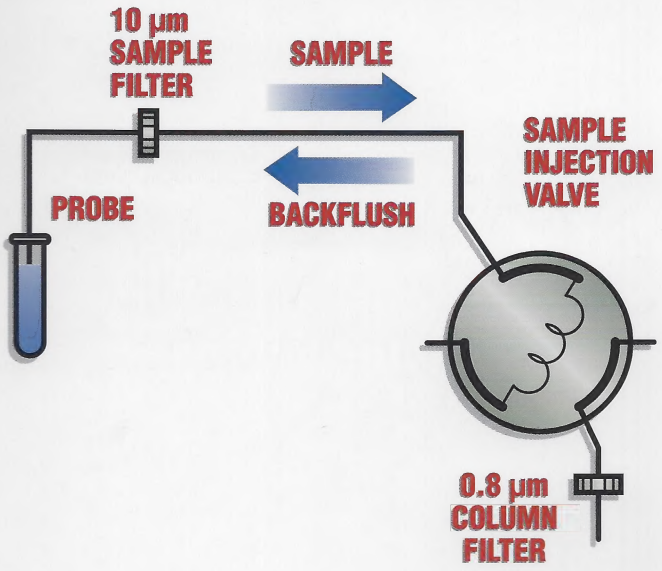


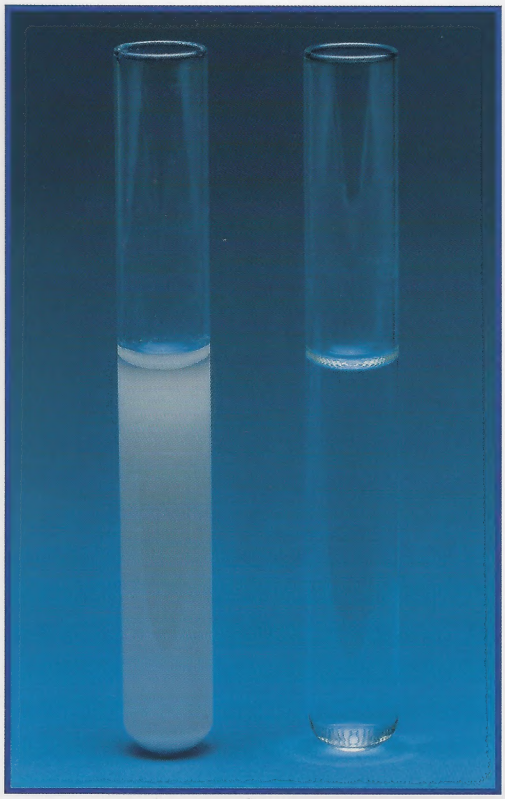

Anion Gradient
1 Fluoride 1 mg/L
2 Formate 3 mg/L
3 Chlorite 3 mg/L
4 Bromate 5 mg/L
5 Chloride 20 mg/L
6 Nitrite-N 2 mg/L
7 Chlorate 5 mg/L
8 Nitrate-N 5 mg/L
9 Bromide 5 mg/L
10 Phosphate-P 5 mg/L
11 Sulfate 20 mg/L
12 Oxalate 9 mg/L
0 Minutes 10 15 20 25 30

Binary gradient chromatogram of 12 inorganic and organic anions
Columns: QS-A2G Guard and QS-A2 Analytical
Eluent flow rate: 0.9 mL/min up to 10 minutes to 1.1 mL/min at 30 minutes
Eluent concentration: Sodium carbonate; 1 mM up to 5 minutes to 6 mM at 30 minutes

Automated In-Line Sample Filtration

Unique to the IC5000 is an in-line sample filtration system, even in the manual sampling mode. The syringeless sampling system, with or without the automatic sampler, aspirates the sample initially through a 10 µm filter prior to loading the sample into the injection valve loop followed by a 0.8 µm filter. Following injection, the sample line is thoroughly backflushed to prevent any cross-contamination between samples.





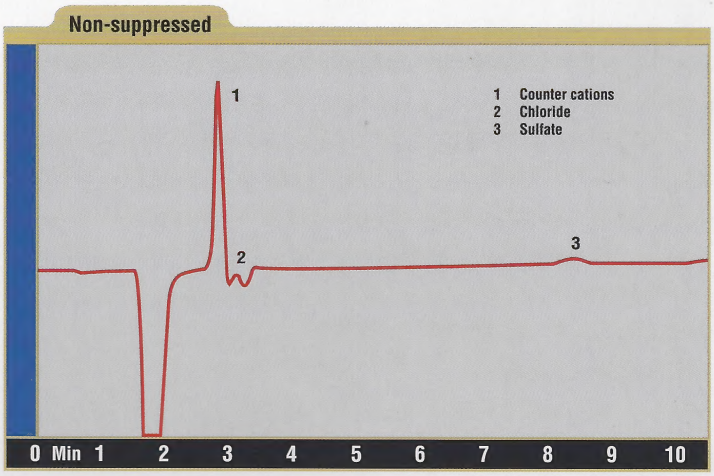
The effectiveness of the automatic filtration system can be seen in this photograph. The milky-colored sample on the left is unfiltered. The completely clear sample on the right is after filtration.

MicroSuppressor™

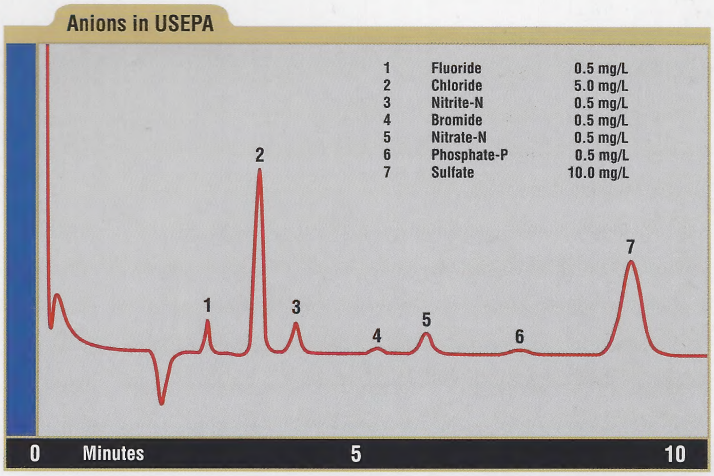
U.S. Patent No. 5,567,307

For most ion chromatographic separations, chemical suppression is critical to determining low analyte concentrations as it increases sensitivity by two orders of magnitude compared to non-suppressed methods by -

- **Decreasing background eluent conductivity**
- **Enhancing analyte conductivity**
- **Eliminating sample counter ions**

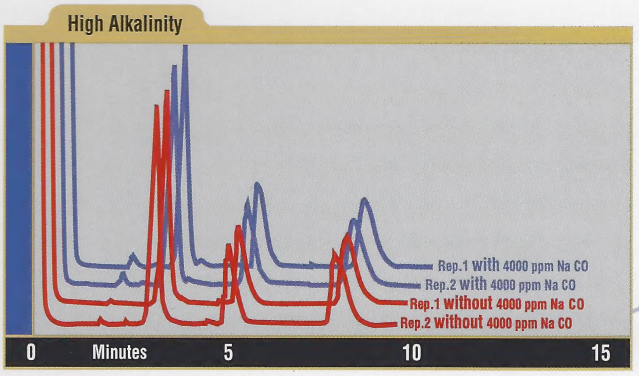


Chromatogram obtained without using MicroSuppressor.



Chromatogram for the anions in USEPA method 300.0, part A.
IC conditions, QS-A1G guard and QS-A1 analytical, eluent; 2.2 mM $NaHCO_3$ + 2.8 mM Na_2CO_3 at 2.0 mL/min, 200 µL sample loop.

Modern packed bed suppressors are the subject of several recent patents including U.S. patent numbers 5,567,307 (1996), 5,597,734 (1997), 5,663,171 (1997) and 5,773,615 (1998). The unique, patented MicroSuppressor Cartridge is a miniaturized packed bed suppressor which is automatically regenerated, in-line, prior to the injection of each sample. As shown in Figure 6, this guarantees maximum and reproducible suppression efficiency for every sample across a wide range of ionic strengths.



Superimposed chromatograms illustrating ability of MicroSuppressor in analyzing samples of high alkalinity.

Approved for use with USEPA, DIN and ISO methods, this solid phase suppressor is the most cost-effective available and eliminates fragile membranes.

While membrane suppressors are clearly effective in providing a means for suppressing background conductivity, they have several disadvantages compared to miniaturized packed bed suppressors. As cited in Dionex, U.S. patent 5,597,734, section 20 -

"The membrane suppressor minimizes many of the foregoing disadvantages. However, membrane suppressors also have certain disadvantages compared to packed bed suppressors such as cost, leakage of regenerant causing higher detector background, the requirement for an external power supply of regenerant solution and the fact that membrane suppressors are complex and not user serviceable. Thus, it would be advantageous to develop an inexpensive, high performance packed bed suppressor approach."

The MicroSuppressor cartridge (4.6 x 20mm) is extremely rugged with a normal life span of thousands of injections. When it needs to be exchanged, the user can perform the operation in less than 5 minutes at a very low cost.

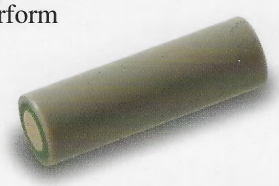


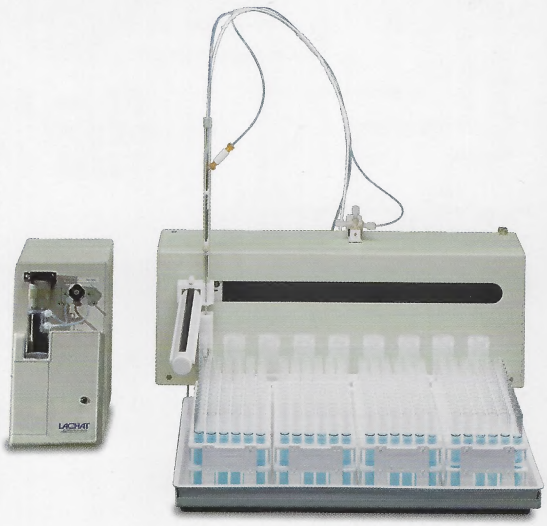
Photo of cartridge is actual size.

Complete Automation with Optional XYZ Sampler and Dual Resolution Dilutor

To accommodate larger sample loads, the XYZ Sampler can be conveniently located on top of the IC5000 to save benchspace. The XYZ offers up to 360 sample and 16 bulk standards positions for both calibration and QC standards and samples. The integral wash bath ensures complete washout of the sampling line to prevent inter-sample carryover and cross-contamination.

The Dual Resolution Dilutor automates preparation of working standards from a stock standard. The unit also performs user-programmed sample dilutions from 1:2 to 1:4,000.

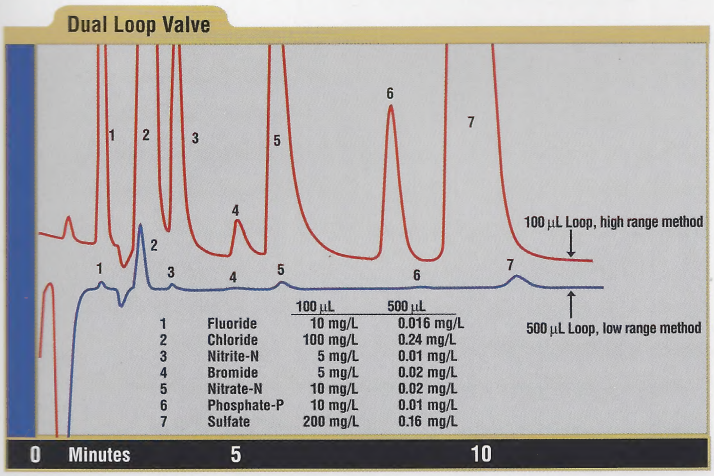
XYZ Sampler and Dual Resolution Dilutor



IC5000 with XYZ Sampler

Range Expansion

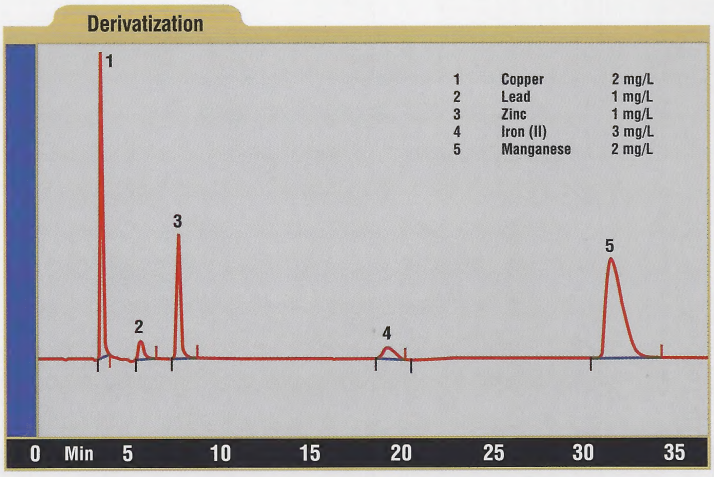
The unique Dual Loop Sample Injection Valve enables the injection volume to be programmed within a batch run to accommodate both high and low range samples and eliminate reruns.

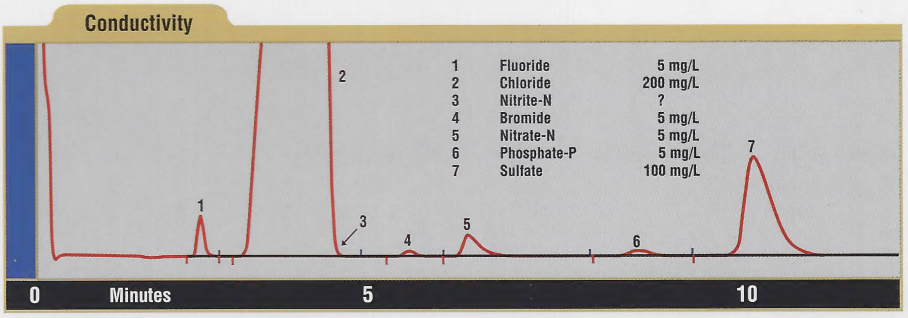

Dual Loop Valve
100 µL Loop, high range method
500 µL Loop, low range method
1 Fluoride 10 mg/L 0.016 mg/L
2 Chloride 100 mg/L 0.24 mg/L
3 Nitrite-N 5 mg/L 0.01 mg/L
4 Bromide 5 mg/L 0.02 mg/L
5 Nitrate-N 10 mg/L 0.02 mg/L
6 Phosphate-P 10 mg/L 0.01 mg/L
7 Sulfate 200 mg/L 0.16 mg/L
100 µL 500 µL
0 Minutes 5 10

Comparative high-low chromatograms.

Post-Column Derivatization and Colorimetric Detection

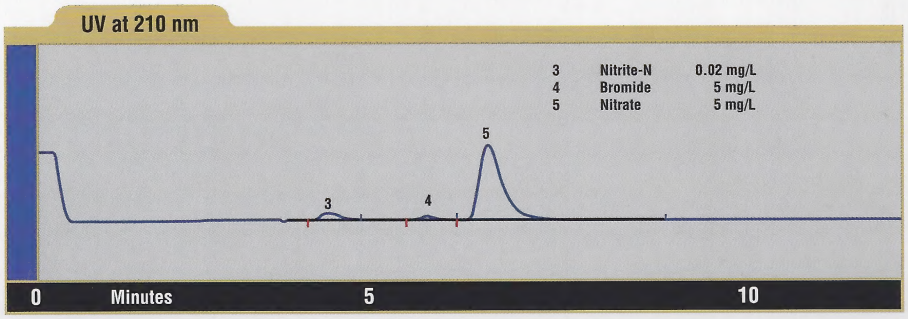
Using post-column derivatization/Vis detection to profile such species as transition metals, bromate (USEPA 317), chromium (VI) and cyanides.





Enhanced Detection of UV Absorbing Ions

To complement conductimetric detection using Sequential UV Detection.



DIN ISO EN 10302-2

Analytical Methods

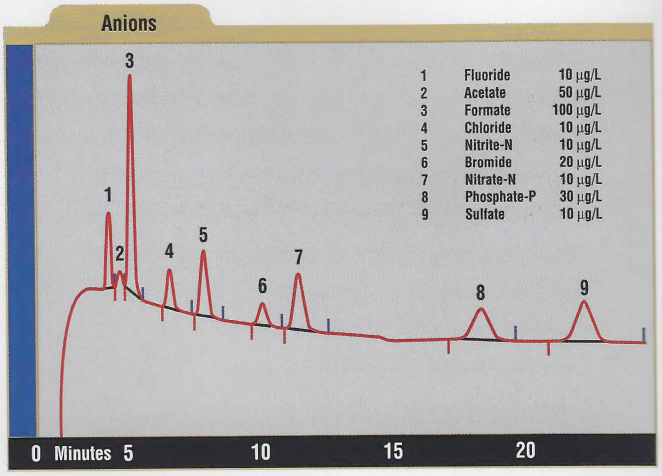
The IC5000 runs the complete suite of USEPA, ISO and DIN ion chromatographic methods and many others. Whether you are doing ppb determinations of ions in drinking water or high ppm levels in dirty wastewater samples, the IC5000 offers the exact method you need. Plus, the optional quaternary gradient elution capability ensures successful separations of even the most complex environmental samples.

USEPA IC Methods

METHOD NUMBER	TITLE
218.6 Chromium (VI)	Determination of dissolved hexavalent chromium in drinking water, groundwater, and industrial wastewater effluents by ion chromatography
300.0, Part A: Bromide, chloride, fluoride, nitrate, nitrite, orthophosphate-P, sulfate	Determination of inorganic anions by ion chromatography
300.1, Part A. - Common anions Bromide, chloride, fluoride, nitrate, nitrite, orthophosphate-P, and sulfate	Determination of inorganic anions in drinking water by ion chromatography
300.1, Part B. - Inorganic disinfection by-products Bromate, bromide, chlorate, chlorite	Determination of inorganic anions in drinking water by ion chromatography
314.0 Perchlorate	Determination of perchlorate in drinking water using ion chromatography
317.0 Bromate, bromide, chlorate, chlorite	Determination of inorganic oxyhalide disinfection by-products in drinking water using ion chromatography with the addition of a postcolumn reagent for trace bromate analysis

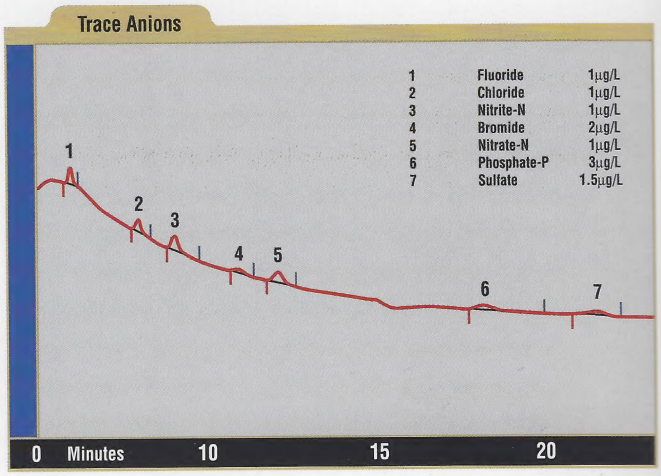
ISO/DIN IC Methods

METHOD NUMBER	TITLE
ISO 10304-1, Part 1: Method for water with low contamination	Water quality - Determination of dissolved fluoride, chloride, nitrite, orthophosphate, bromide, nitrate, and sulfate ions, using liquid chromatography of ions
ISO 10304-2, Part 2: Determination of anions in waste-water	Water quality - Determination of dissolved anions by liquid chromatography of ions: Determination of bromide, chloride, nitrate, nitrite, orthophosphate, and sulfate
ISO 10304-3, Part 3:	Water quality - Determination of dissolved anions by liquid chromatography of ions: Determination of chromate, iodide, sulfite, thiocyanate and thiosulfate
ISO 10304-4, Part 4:	Water quality - Determination of dissolved anions by liquid chromatography of ions: Determination of chlorate, chloride, and chlorite in water with low contamination
ISO/DIS 14911-1, Part 1: Method for water and wastewater (This is still in draft stage)	Water quality - Determination of dissolved Li^+, Na^+, NH_4^+, K^+, Mn^{2+}, Mg^{2+}, Sr^{2+}, and Ba^{2+} using liquid chromatography of ions



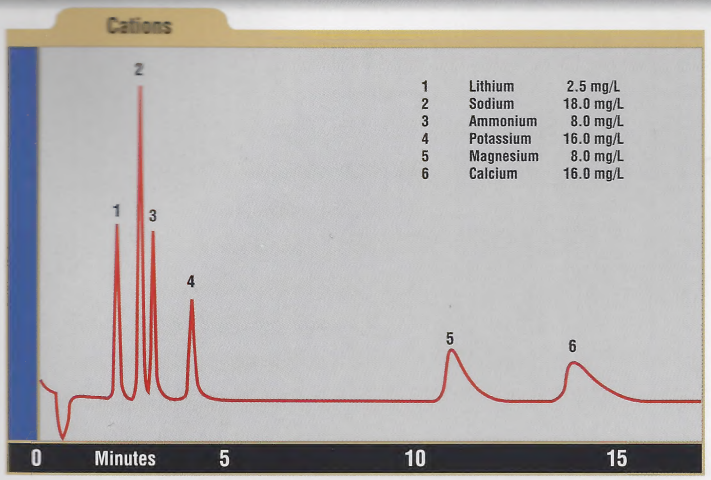
Chromatogram for trace anions in the presence of formate and actate.

Columns: QS-A7G (4.6 x 10 mm) Guard, QS-A7 (4.6 x 150 mm) Analytical
Eluent: 4 mM $NaHCO_3$ + 1mM Na_2CO_3, 0.9 mL/min
Sample loop: 750 µL



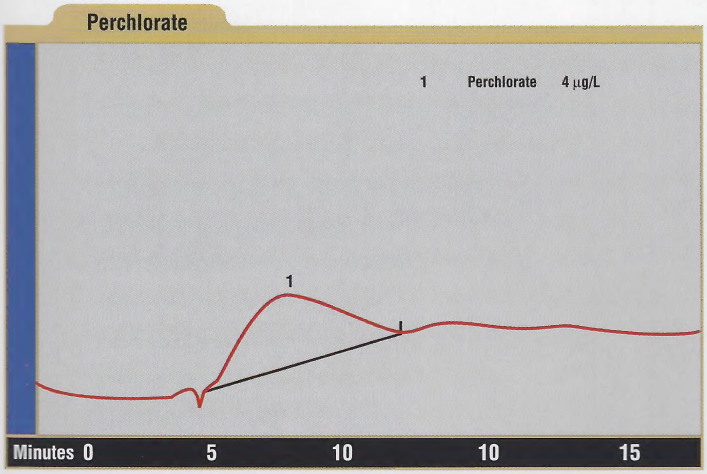
Chromatogram for trace anions.

Columns: QS-A7G (4.6 x 10 mm) Guard, QS-A7 (4.6 x 150 mm) Analytical
Eluent: 4 mM $NaHCO_3$ + 1mM Na_2CO_3, 0.9 mL/min
Sample loop: 750 µL



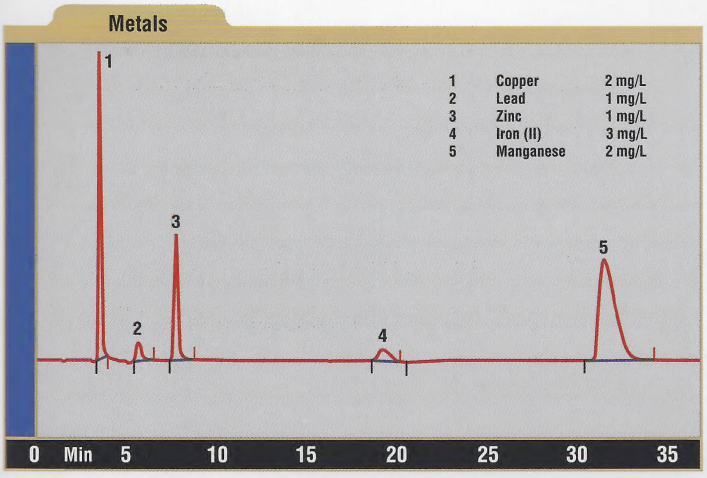
Chromatogram for cations. Lithium, sodium, ammonium, potassium, magnesium, and calcium at ppm levels in waters – synthetic standard.

Columns: QS-C3G (4.6 x 10 mm) Guard, QS-C3 (4.6 x 100 mm) Analytical
Eluent: 2.4 mM methane sulfonic acid, 1.8 mL/min
Sample loop: 25 µL



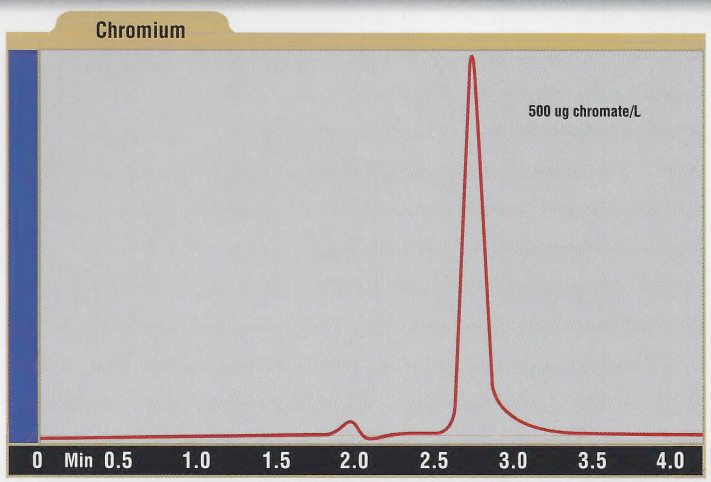
Perchlorate (4 µg/L) in waters – synthetic standard.

Columns: QS-A6G (4.6 x 50 mm) Guard and QS-A6 (4.6 x 250 mm) Analytical
Eluent: 30 mM LiOH + 10 mM cyanophenol + 1.0% (v/v) methanol, 1.0 mL/min
Sample loop: 1000 µL



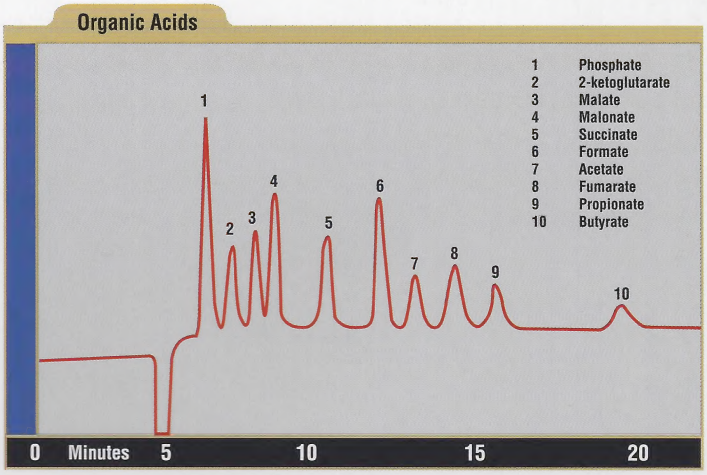
Chromatogram for copper, lead, zinc, iron (II), and manganese in waters.

Columns: QS-M1G (4.6 x 10 mm) Guard, QS-M1 (4.6 x 250 mm) Analytical
Eluent: 2 mM SOS + 40 mM tartaric acid + 3 mM oxalic acid with 5% acetonitrile, (pH = 3.1) 1.0 mL/min
PCR: 4-(2-pyridylazo)resorcinol, 0.5 mL/min
Sample loop: 250 µL



Chromatogram for chromate in waters.

Columns: QS-A1G (4.6 x 50 mm) Guard and QS-A1 (5.5 x 250 mm) Analytical
Eluent: 55.9 mM (NH4)2SO4, 23.1 mM NH4OH, 1.5 mL/min
PCR: 2 mM diphenylcarbazide, 10% methanol (v/v), 0.5 M sulfuric acid, 0.5 mL/min
Detection: Colorimetric at 530 nm
Sample loop:1000 µL



Chromatogram for determination of phosphate, 2-ketoglutarate, malate, malonate, succinate, formate, acetate, fumarate, propionate, and butyrate by ion-exclusion chromatography.

Columns: QS-OA1G (3.0 x 20 mm) Guard and QS-OA1 (7.8 x 300 mm) Analytical
Eluent : 8 mM H2SO4, 0.6 mL/min
Sample loop: 50 µL

Warranty and Service

Unique to the industry, Lachat Instruments provides a Two Year Warranty on the IC5000. This provides you with security for your investment and guarantees economical cost of ownership.

In addition, a Lachat original called the Loaner Module Program, used for nearly 20 years, provides you with a module to use in the event that one of yours needs repair. The major components of the IC5000 can be easily removed and replaced with a loaner so instrument downtime is minimized.

You will also find that our Technical Support staff is very accessible. You call, we respond! Contact us any way you want - by telephone, fax or email.

QuikChem® 8000 Ion Chromatography System

In addition to the standalone IC5000, Lachat Instruments also offers the unique IC Option. This enables ion chromatography and flow injection analysis to operate simultaneously and independently on the same instrument platform (U.S. Patent No. 5,492,831) which adds tremendous flexibility to your laboratory for performing inorganic ion analysis.

Integrated with the flow injection analyzer or available as a standalone instrument, QuikChem Ion Chromatography adds the power to profile samples for a class of ionic species. While flow injection analysis is ideally suited for processing relatively large numbers of samples for between 2 and 4 analytes simultaneously, ion chromatography enables the determination of multiple ions from a single injection.

FIA and IC are complementary analytical techniques that are commonly used in the same laboratory. By incorporating both technologies into a single instrument, the following benefits are achieved:

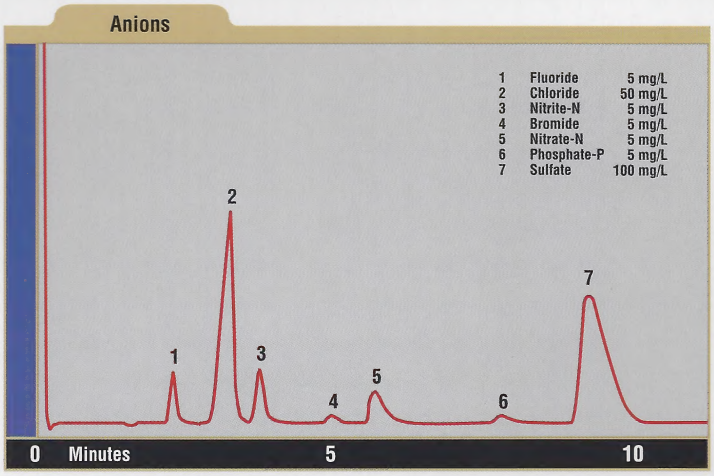
- **Operation of FIA and IC simultaneously and independently on the same instrument platform**
- **Shared use of several peripherals including sampler, dilutor, sampling pump, electronics unit and data station**
- **Uniform operating protocols**
- **Training and support provided by one company**
- **Reduced footprint**

The QuikChem IC Option is available with your original QuikChem 8000 system purchase, integrated at the factory, or as a simple field upgrade.

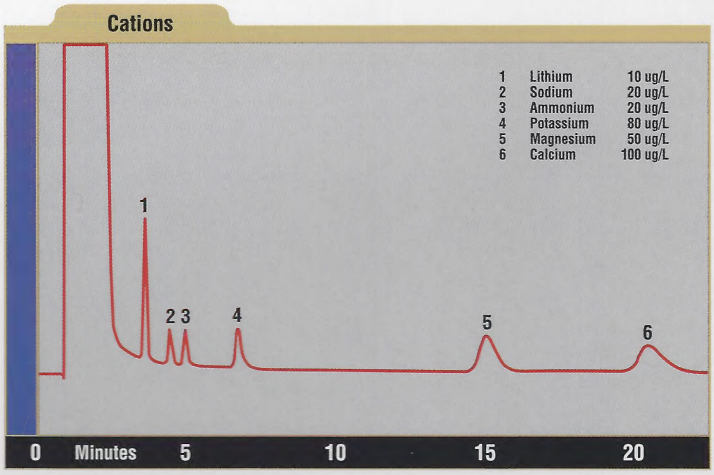
With the availability of both Flow Injection Analysis and Ion Chromatography, Lachat Instruments offers the most comprehensive ion analysis solutions available today. For complete information on QuikChem Ion Chromatographs, please request Lachat Catalog No. 1103/6-97.

FIA and IC Methods Commonly Used for USEPA/ISO/DIN Regulatory Monitoring of Wastewater and Drinking Water

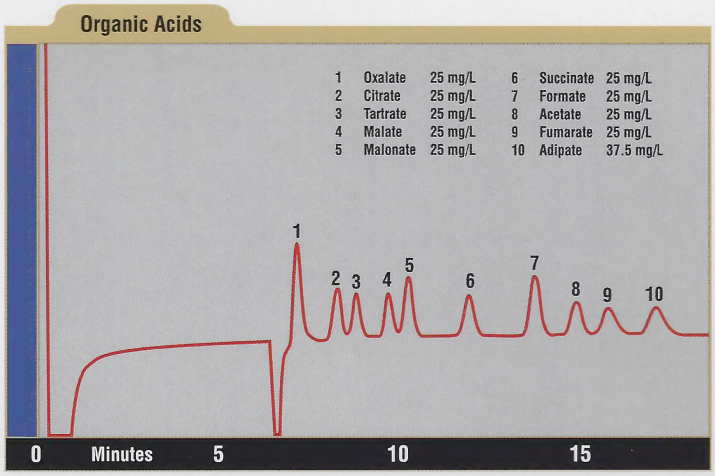
Alkalinity	Hardness
Ammonia	Kjeldahl Nitrogen
Bromate	Nitrate
Bromide	Nitrate + Nitrite
Chlorate	Nitrite
Chloride	Ortho phosphate
Chlorite	Phenolics
Chromium	Phosphorus
Conductivity	Silicate
Cyanide	Sulfate
Fluoride	Surfactants



Just one sample injection into a QuikChem IC Anion Profiling Module provides concentration values for 7 anions in under 10 minutes.



Selection of the QuikChem Cation Profiling Module will allow determination of both alkali metals and alkaline earths in about 20 minutes.


Organic Acids
1 Oxalate 25 mg/L
2 Citrate 25 mg/L
3 Tartrate 25 mg/L
4 Malate 25 mg/L
5 Malonate 25 mg/L
6 Succinate 25 mg/L
7 Formate 25 mg/L
8 Acetate 25 mg/L
9 Fumarate 25 mg/L
10 Adipate 37.5 mg/L
1
2 3 4 5 6 7 8 9 10
0 Minutes 5 10 15

Up to 10 organic acids can be determined in under 20 minutes by inserting the QuikChem Organic Acids Profiling Module.

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